

Sub A!

5

10

1. An oscillator having a fundamental frequency and having low phase noise comprising:
 - a frequency dependent amplifier;
 - a frequency dependent feedback device in communication with an output of said frequency dependent amplifier and an input of said frequency dependent amplifier; and
 - an attenuating device in communication with said frequency dependent amplifier to attenuate noise signals having a frequency much less than the fundamental frequency

15

2. The oscillator of claim 1 wherein said attenuating device has a characteristic such that the fundamental frequency is from approximately ten times to twenty times a high pass bandwidth of a combination of the frequency dependent amplifier and the attenuating device.

15

3. The oscillator of claim 1 wherein said amplifier amplifies an input by a predetermined gain factor, and

20 *See cl. 5* wherein said frequency dependent feedback device comprises:
a frequency dependent gain determining in communication with said impedance amplifier, wherein a maximum gain of said frequency dependent amplifier occurs at the fundamental frequency.

4. The oscillator of claim 3 wherein said amplifier comprises:

5 a pair of cross-coupled MOS transistors having a drain of each of said pair of cross-coupled MOS transistors being in communication with a gate of the other of said pair of cross-coupled MOS transistors and to a corresponding terminal of said frequency dependent gain determining impedance;

10 a first current source having a first terminal in communication with a source of a first one of said pair of cross-coupled MOS transistors and to a first terminal of said attenuating device; and

15 a second current source having a first terminal in communication with a source of a second one of said pair of cross-coupled MOS transistors and to a second terminal of said attenuating device.

20 5. The oscillator of claim 3 wherein said frequency dependent gain determining impedance comprises:

15 at least one inductor in communication with said amplifier and a first terminal of a voltage source; and

20 at least one capacitor in communication with said amplifier and a second terminal of the voltage source.

25 6. The oscillator of claim 4 wherein said attenuating device comprises a capacitor.

7. The oscillator of claim 3, further comprising a second attenuating device,

and

wherein said amplifier comprises:

a first pair of cross-coupled MOS transistors of a first conductivity type

5

having a drain of each of said first pair of cross-coupled MOS

transistors being in communication with a gate of the other of said

first pair of cross-coupled MOS transistors and to a corresponding

terminal of said frequency dependent gain determining impedance;

a first current source in communication with a source of one of said

10 first pair of cross-coupled MOS transistors of the first conductivity

type and with a first terminal of said attenuating device;

a second current source in communication with a source of a second

one of said first pair of cross-coupled MOS transistors of the first

conductivity type and with a second terminal of said attenuating

15 device;

a second pair of cross-coupled MOS transistors of a second

conductivity type whereby a drain of each of said second pair of

cross-coupled MOS transistors is connected to a gate of the other

of said second pair of cross-coupled MOS transistors and to one

20 terminal of said frequency dependent gain determining impedance;

a third current source in communication with a source of one of said

second pair of cross-coupled MOS transistors and with a first

terminal of said second attenuating device; and

*Sub
10*

Sub A2

a fourth current source in communication with a source of the other of said second pair of cross-coupled MOS transistors of the second conductivity type and with a fourth second terminal of said second attenuating device.

5

8. The oscillator of claim 7 wherein said attenuating device comprises a first capacitor.

10

9. The oscillator of claim 7 wherein said second attenuating device comprises a second capacitor.

15

10. An LC oscillator having a fundamental frequency and having low phase noise comprising:

a frequency dependent amplifier comprising:

a pair of cross-coupled MOS transistors of a first conductivity

type, a drain of each of said pair of cross-coupled MOS

being in communication with a gate of the other one of said

pair of cross-coupled MOS transistors,

a first current source in communication with a source of one of

20

said pair of cross-coupled MOS transistors, and

a second current source in communication with a source of

another of said pair of cross-coupled MOS transistors;

a frequency dependent gain determining circuit comprising

Sub A3

1 a first inductor in communication with the drain of said one of
said pair of cross-coupled MOS transistors and a first
terminal of a voltage source,
5 a second inductor in communication with the drain of the other
of said pair of cross-coupled MOS transistors and the first
terminal of the voltage source,
10 a first capacitor in communication with the drain of said one of
said of said pair of cross-coupled MOS transistors and a
second terminal of the voltage source, and
15 a second capacitor in communication with the drain of the other
of said pair of cross-coupled MOS transistors and the
second terminal of the voltage source; and
an attenuating circuit in communication with said frequency
dependent amplifier to reduce the gain of signals having
frequencies less than the fundamental frequency to decrease
the phase noise, wherein said attenuating circuit comprises a
third capacitor in communication with said first and second
current sources.

20 11. The LC oscillator of the claim 10 wherein said attenuating device has a
characteristic such that the fundamental frequency is from approximately
ten times to twenty times a high pass bandwidth of a combination of said
frequency dependent amplifier and said attenuating device.

12. The LC oscillator of the claim 10 wherein said amplifier further comprises:

a second pair of cross-coupled MOS transistors of a second conductivity type each having a drain connected to a gate of the other of second pair of cross-coupled MOS,

5 a third current source in communication with a source of one of said second pair of cross-coupled MOS transistors, and

a fourth current source in communication with a source of the other of said second pair of cross-coupled MOS.

10 13. The LC oscillator of claim 12 wherein said attenuating circuit further comprises a fourth capacitor in communication with said third and fourth current sources.

15 14. An RF communication device comprising:

an oscillator having a fundamental frequency and having low phase noise comprising:

a frequency dependent amplifier;

a frequency dependent feedback device in communication with

20 an output of said frequency dependent amplifier and an

input of said frequency dependent amplifier; and

an attenuating device in communication with said frequency

dependent amplifier to attenuate noise signals having a frequency

*Sub
Off*

much less than the fundamental frequency.

15. The RF communication device of claim 14 wherein said attenuating device has a characteristic such that the fundamental frequency is from approximately ten times to twenty times a high pass bandwidth of a combination of the frequency dependent amplifier and the attenuating device.

16. The RF communication device of claim 14 wherein said device comprises an RF transmitter and said oscillator comprises a carrier oscillator to provide a carrier frequency signal for said RF transmitter.

17. The RF communication device of claim 15 wherein said device comprises an RF receiver and said oscillator comprises a local oscillator to demodulate a carrier frequency signal received by said RF receiver.

18. The RF communication device of claim 15 wherein said amplifier amplifies an input signal by a predetermined gain factor, and wherein said frequency dependent feedback device comprises:

20 a frequency dependent gain determining impedance in communication with said amplifier, wherein a maximum gain of said frequency dependent amplifier occurs at the fundamental frequency.

19. The RF communication device of claim 18 wherein said amplifier comprises:

a pair of cross-coupled MOS transistors having a drain of each of said 5 pair of cross-coupled MOS transistors being in communication with a gate of the other of said pair of cross-coupled MOS transistors and to a corresponding terminal of said frequency dependent gain determining impedance;

a first current source having a first terminal in communication with a 10 source of a first one of said pair of cross-coupled MOS transistors and with a first terminal of said attenuating device; and

a second current source having a first terminal in communication with a source of a second one of said pair of cross-coupled MOS 15 transistors and with a second terminal of said attenuating device.

20. The RF communication device of claim 18 wherein said frequency dependent gain determining impedance comprises:

at least one inductor in communication with said amplifier and a first 20 terminal of a voltage source; and

at least one capacitor in communication with said amplifier and a second terminal of the voltage source.

21. The RF communication device of claim 19 wherein said attenuating device

comprises a capacitor.

22. The RF communication device of claim 19 further comprising a second attenuating device, and

wherein said amplifier comprises:

a first pair of cross-coupled MOS transistors of a first conductivity type having a drain of each of said first pair of cross-coupled MOS transistors being in communication with a gate of the other of said first pair of cross-coupled MOS transistors and to a corresponding terminal of said frequency dependent gain determining impedance;

a first current source in communication with a source of one of said first pair of cross-coupled MOS transistors of the first conductivity type and with a first terminal of said attenuating device;

a second current source in communication with a source of a second one of said first pair of cross-coupled MOS transistors of the first conductivity type and with a second terminal of said attenuating device;

a second pair of cross-coupled MOS transistors of a second conductivity type wherein a drain of each of said second pair of cross-coupled MOS transistors is connected to a gate of the other of said second pair of cross-coupled MOS

transistors and to one terminal of said frequency dependent gain determining impedance;

5 a third current source in communication with a source of one of said second pair of cross-coupled MOS transistors and with a first terminal of said second attenuating device; and a fourth current source in communication with a source of the other of said second pair of cross-coupled MOS transistors of the second conductivity type and to a fourth second terminal of said second attenuating device.

10 23. The RF communication device of claim 22 wherein said attenuating device comprises a first capacitor.

15 24. The RF communication device of claim 22 wherein said second attenuating device comprises a second capacitor.

25. A frequency transforming apparatus having low phase noise comprising:
20 a first oscillator having a first fundamental frequency comprising:
a first frequency dependent amplifier;

a first frequency dependent feedback device in communication with an output of said first frequency dependent amplifier and an input of said first frequency dependent amplifier; and a first attenuating device in communication with said first

*Sub
AS*

frequency dependent amplifier to attenuate noise signals having a frequency much less than the first fundamental frequency;

5 a second oscillator having a second fundamental frequency comprising:

a second frequency dependent amplifier;

a second frequency dependent feedback device in communication with an output of said second frequency dependent amplifier and an input of said second frequency dependent amplifier; and

10 a second attenuating device in communication with said second frequency dependent amplifier to attenuate noise signals having a frequency much less than the second fundamental frequency; and

15 a frequency dependent coupling circuit having a third fundamental frequency in communication with an output of the first oscillator and an input of the second oscillator, said frequency dependent coupling circuit comprising:

a third frequency amplifier, and

20 a second attenuating device in communication with said third frequency dependent amplifier to attenuate noise signals having frequencies much less than the third fundamental frequency.

Sub
AS
10

26. The frequency transforming apparatus of claim 25 wherein said first and second attenuating devices each have a respective characteristic such that the first and second fundamental frequencies are from approximately 5 ten times to twenty times a high pass bandwidth of a respective combination of said first and second frequency dependent amplifiers, said first and second attenuating devices and said third frequency dependent amplifier and said third attenuating device.

10 27. The frequency transforming apparatus of claim 25 wherein said first, second and second frequency dependent amplifiers each amplifies an input by a respective predetermined gain factor, wherein said first frequency dependent feedback device comprises: 15 a first frequency dependent gain determining impedance in communication with said first amplifier, wherein a first maximum gain of said first frequency dependent amplifier occurs at the first fundamental frequency, and wherein said second frequency dependent feedback device 20 comprises: a second frequency dependent gain determining impedance in communication with said second amplifier, wherein a second maximum gain of said second frequency dependent amplifier occurs at the second fundamental frequency.

28. The frequency transforming apparatus of claim 27 wherein said first amplifier comprises:

5 a first pair of cross-coupled MOS transistors having a drain of

each of said first pair of cross-coupled MOS transistors

being in communication with a gate of the other of said first

pair of cross-coupled MOS transistors and to a

corresponding terminal of said first frequency dependent

gain determining impedance;

10 a first current source having a first terminal in communication

with a source of a first one of said first pair of cross-coupled

MOS transistors and with a first terminal of said first

attenuating device; and

15 a second current source having a first terminal in

communication with a source of a second one of said first

pair of cross-coupled MOS transistors and with a second

terminal of said first attenuating device, and

20 wherein said second amplifier comprises:

a second pair of cross-coupled MOS transistors having a drain

of each of said second pair of cross-coupled MOS

transistors being in communication with a gate of the other

of said second pair of cross-coupled MOS transistors and to

25 a corresponding terminal of said second frequency

dependent gain determining impedance;
a third current source having a first terminal in communication
with a source of a first one of said second pair of cross-
coupled MOS transistors and with a first terminal of said
second attenuating device; and
5
a fourth current source having a first terminal in communication
with a source of a second one of said second pair of cross-
coupled MOS transistors and with a second terminal of said
second attenuating device.

10

29. The frequency transforming apparatus of claim 27 wherein each of said
first and second frequency dependent gain determining impedance
comprises:
15
at least one inductor in communication with a respective one of said
first and second amplifiers and a first terminal of a voltage source;
and
at least one capacitor in communication with said a respective one of
said first and second amplifiers and a second terminal of the
voltage source.

20

30. The frequency transforming apparatus of claim 29 wherein the first,
second and third attenuating devices each comprises a capacitor.

31. The frequency transforming apparatus of claim 27 wherein said first and second oscillators each comprise another attenuating device,

wherein said first and second amplifiers each comprises:

a first pair of cross-coupled MOS transistors of a first conductivity type having a drain of each of said first pair of cross-coupled MOS transistors being in communication with a gate of the other of said first pair of cross-coupled MOS transistors and to a corresponding terminal of a respective one of said frequency dependent gain determining impedances;

a first current source in communication with a source of one of said first pair of cross-coupled MOS transistors of the first conductivity type and with a first terminal of a respective one of said attenuating devices;

a second current source in communication with a source of a second one of said first pair of cross-coupled MOS transistors of the first conductivity type and with a second terminal of a respective one of said attenuating devices;

a second pair of cross-coupled MOS transistors of a second conductivity type wherein a drain of each of said second pair of cross-coupled MOS transistors is connected to a gate of the other of said second pair of cross-coupled MOS transistors and to one terminal of a respective one of said frequency dependent

gain determining impedances;
a third current source in communication with a source of one of
said second pair of cross-coupled MOS transistors and with a
first terminal of a respective one of said other attenuating
5 devices; and
a fourth current source in communication with a source of the other
of said second pair of cross-coupled MOS transistors of the
second conductivity type and to a fourth second terminal of a
respective one of said other attenuating device.

10

32. The frequency transforming apparatus of claim 31 wherein said
attenuating device and said other attenuating device each comprises a
first capacitor.

15

33. The frequency transforming apparatus of claim 32 wherein said
attenuating device and said other attenuating device each comprises a
second capacitor.

20

34. The frequency transforming apparatus of claim 25 wherein said frequency
dependent coupling circuit is selected from the group of coupling circuits
consisting of phase shifters, frequency mixers, frequency shifters,
modulators, and demodulators.

35. A multiple frequency oscillation circuit having low phase noise, comprising:

a first oscillator having a first fundamental frequency comprising:

a first frequency dependent amplifier;

a first frequency dependent feedback device in communication with

an output of said first frequency dependent amplifier and an

input of said first frequency dependent amplifier; and

a first attenuating device in communication with said first frequency

dependent amplifier to attenuate noise signals having a frequency

much less than the first fundamental frequency;

a second oscillator having a second fundamental frequency

comprising:

a second frequency dependent amplifier;

a second frequency dependent feedback device in communication

with an output of said second frequency dependent amplifier

and an input of said second frequency dependent amplifier; and

a second attenuating device in communication with said second

frequency dependent amplifier to attenuate noise signals having

a frequency much less than the second fundamental

frequency; and

a frequency dependent coupling circuit having a third fundamental.

frequency in communication with an output of the first oscillator and

an input of the second oscillator, said frequency dependent

5

10

Sur
a'e

15

20

coupling circuit comprising:
a third frequency amplifier, and
a second attenuating device in communication with said third
frequency dependent amplifier to attenuate noise signals having
frequencies much less than the third fundamental frequency.

5

36. The multiple frequency oscillation circuit of claim 35 said first and second attenuating devices each has a respective characteristic such that the first and second fundamental frequencies are from approximately ten times to twenty times a high pass bandwidth of a respective combination of said first and second frequency dependent amplifiers, said first and second attenuating devices and said third frequency dependent amplifier and said third attenuating device.

15 37. The multiple frequency oscillation circuit of claim 35 wherein said first, second and second frequency dependent amplifiers each amplifies an input by a respective predetermined gain factor, wherein said first frequency dependent feedback device comprises:

20 communication with said first amplifier, wherein a first maximum
gain of said first frequency dependent amplifier occurs at the

wherein said second frequency dependent feedback device

comprises:

a second frequency dependent gain determining impedance in communication with said second amplifier, wherein a second maximum gain of said second frequency dependent amplifier occurs at the second fundamental frequency

5

38. The multiple frequency oscillation circuit of claim 37 wherein said first amplifier comprises:

10 a first pair of cross-coupled MOS transistors having a drain of each of said first pair of cross-coupled MOS transistors being in communication with a gate of the other of said first pair of cross-coupled MOS transistors and to a corresponding terminal of said first frequency dependent gain determining impedance;

15 a first current source having a first terminal in communication with a source of a first one of said first pair of cross-coupled MOS transistors and with a first terminal of said first attenuating device; and

20 a second current source having a first terminal in communication with a source of a second one of said first pair of cross-coupled MOS transistors and with a second terminal of said first attenuating device, and

wherein said second amplifier comprises:

a second pair of cross-coupled MOS transistors having a drain

of each of said second pair of cross-coupled MOS
transistors being in communication with a gate of the other
of said second pair of cross-coupled MOS transistors and to
a corresponding terminal of said second frequency
dependent gain determining impedance;

5

a third current source having a first terminal in communication
with a source of a first one of said second pair of cross-
coupled MOS transistors and with a first terminal of said
second attenuating device; and

10

a fourth current source having a first terminal in communication
with a source of a second one of said second pair of cross-
coupled MOS transistors and with a second terminal of said
second attenuating device.

2 3 3 3 4 2 1 4 3 6 9 0 0

15 39. The multiple frequency oscillation circuit of claim 37 wherein each of said
first and second frequency dependent gain determining impedances
comprises:

20

at least one inductor in communication with a respective one of said
first and second amplifiers and a first terminal of a voltage source;

and

at least one capacitor in communication with said a respective one of
said first and second amplifiers and a second terminal of the
voltage source.

40. The multiple frequency oscillation circuit of claim 39 wherein said first, second and third attenuating devices each comprises a capacitor.

5 41. The multiple frequency oscillation circuit of claim 37 wherein said first and second oscillators each comprises another attenuating device, wherein said first and second amplifiers each comprises:

10 a first pair of cross-coupled MOS transistors of a first conductivity type having a drain of each of said first pair of cross-coupled MOS transistors being in communication with a gate of the other of said first pair of cross-coupled MOS transistors and to a corresponding terminal of a respective one of said frequency dependent gain determining impedances;

15 a first current source in communication with a source of one of said first pair of cross-coupled MOS transistors of the first conductivity type and with a first terminal of a respective one of said attenuating devices;

20 a second current source in communication with a source of a second one of said first pair of cross-coupled MOS transistors of the first conductivity type and with a second terminal of a respective one of said attenuating devices;

a second pair of cross-coupled MOS transistors of a second

conductivity type whereby a drain of each of said second pair of cross-coupled MOS transistors is connected to a gate of the other of said second pair of cross-coupled MOS transistors and to one terminal of a respective one of said frequency dependent gain determining impedances;

5

a third current source in communication with a source of one of said second pair of cross-coupled MOS transistors and with a first terminal of a respective one of said other attenuating devices; and

10

a fourth current source in communication with a source of the other of said second pair of cross-coupled MOS transistors of the second conductivity type and to a fourth second terminal of a respective one of said other attenuating device.

15

42. The multiple frequency oscillation circuit of claim 41 said attenuating device and said other attenuating device each comprises a first capacitor.

43. The multiple frequency oscillation circuit of claim 42 wherein said attenuating device and said other attenuating device each comprises a second capacitor.

20

44. The multiple frequency oscillation circuit of claim 35 wherein said frequency dependent coupling circuit generate phase shifts of the first and

second fundamental frequencies.

45. The multiple frequency oscillation circuit of claim 44 wherein the first and second fundamental frequencies 90° out of phase.

- 46.

46. A quadrature oscillator circuit having low phase noise, comprising:

a first oscillator having a first fundamental frequency comprising:

a first frequency dependent amplifier device;

a first frequency dependent feedback device in communication with

an output of said first frequency dependent amplifier and an

input of said first frequency dependent amplifier to feed a

portion of an amplified signal having the first fundamental

frequency to an input of said first frequency dependent

amplifier; and

5.1.1. *Introduction*

15 a first attenuating device in communication with said first frequency

dependent gain amplifier for reducing the gain of said first

frequency dependent amplifier for signals having frequencies

much less than the first fundamental frequency to decrease saturation.

11. *Leucosia* (Leucosia) *leucostoma* (Fabricius) (Fig. 11)

20 a first frequency dependent coupling circuit having a second

fundamental frequency having an input in communication with the

output of the first frequency dependent amplifier, said first

frequency dependent coupling circuit comprising:

a second frequency dependent amplifier, and
a second attenuating device in communication with said second
frequency dependent amplifier for reducing the gain of said
frequency dependent amplifier for signals having frequencies
much less than said second fundamental frequency to decrease
said phase noise;

a second oscillator to generate a second fundamental signal having a

third fundamental frequency having low phase noise, in

communication with an output of the second frequency dependent

amplifier, and said second oscillator comprising:

a third frequency dependent amplifier;

a third frequency dependent feedback device in communication

with an output of said third frequency dependent amplifier and

an input of said third frequency dependent amplifier to feed a

portion of an amplified signal having the third fundamental

frequency to an input of said third frequency dependent

amplifier; and

third attenuating

a third attenuating device in communication with the third frequency dependent amplifier for reducing the gain of said third frequency dependent amplifier for signals having frequencies much less than the third fundamental frequency to decrease the phase noise; and

second frequency dependent coupling circuit having a fourth

fundamental frequency having an input in communication with the output of said third frequency dependent amplifier and the input of said first frequency dependent such that a phase of the third fundamental frequency is reversed relative to a phase of the first fundamental frequency, and comprising:

5

a fourth frequency dependent amplifier, and

10

a fourth attenuating device in communication with said second

frequency dependent amplifier for reducing the gain of said

fourth frequency dependent amplifier for signals having

frequencies much less than said fourth fundamental frequency

to decrease the phase noise.

47. The quadrature oscillator circuit of claim 46 wherein said first, second, third and fourth attenuating devices each has a characteristic such that the first, second, third and fourth fundamental frequencies are each from approximately ten times to twenty times a high pass bandwidth of a respective combination of said first frequency dependent amplifier and said first attenuating device and of said third frequency dependent amplifier and said third attenuating device.

20

48. The quadrature oscillator circuit of claim 46 wherein said first, second, third and fourth frequency dependent amplifiers each amplify an input signal by respective predetermined gain factors, wherein said first,

second, third and fourth frequency dependent each comprises:
a frequency dependent gain determining impedance in communication
with a corresponding one of said first, second, third and fourth
frequency dependent amplifiers, wherein the maximum gain of
each of said corresponding one of said first, second, third and
fourth frequency dependent amplifiers, occurs at a respective one
of the first, second, third and fourth fundamental frequencies.

5

49. The quadrature oscillator circuit of claim 48 wherein each of said first,
10 second, third and fourth amplifiers comprises:
a pair of cross-coupled MOS transistors whereby a drain of each of
pair of cross-coupled MOS transistors is in communication with a
gate of another one of said pair of cross-coupled MOS transistors
and said frequency dependent gain determining impedance;
15 a first current source in communication with a source of one of said
pair of cross-coupled MOS transistors and to a first terminal of a
voltage source and to a first terminal of a respective one of said
first, second, third and fourth attenuating devices; and
a second current source in communication with a source of the other
20 one of said pair of cross-coupled MOS transistors and to a first
terminal of a respective one of said first, second, third and fourth
attenuating devices.

50. The quadrature oscillator circuit of claim 48 wherein each of said first, second, third and fourth frequency dependent gain determining impedances comprises:

5 at least one inductor in communication with of a respective one of said first, second, third and fourth amplifiers and a second terminal of the voltage source; and

10 at least one capacitor in communication with of a respective one of said first, second, third and fourth amplifiers and a third terminal of the voltage source.

15 51. The quadrature oscillator circuit of claim 50 wherein each of said first, second, third and fourth attenuating devices comprises a capacitor.

52. The quadrature oscillator circuit of claim 48 wherein each of said first, second, third and fourth amplifiers comprises:

20 an additional attenuating device;

a first cross-coupled pair of MOS transistors of the first conductivity type having a drain of each of said first cross-coupled pair of MOS transistors in communication with a gate of the other of said first cross-coupled pair of MOS transistors and to a terminal of a respective one of said first, second, third and fourth frequency dependent gain determining impedances;

a first current source in communication with a source of one of said

first cross-coupled pair of MOS transistors and to a first terminal of a respective one of said first, second, third and fourth attenuating devices;

5 a second current source in communication with a source of the other said first cross-coupled pair of MOS transistors and to a terminal of a respective one of said first, second, third and fourth attenuating devices;

10 a second cross-coupled pair of MOS transistors of the second conductivity type have a drain of each of second cross-coupled pair of MOS transistors in communication with a gate of the other of second cross-coupled pair of MOS transistors and to the first terminal of a respective one of said first, second, third and fourth attenuating devices;

15 a third current source in communication with a source of one of said second cross-coupled pair of MOS transistors and to a first terminal of said additional attenuating device; and

a fourth current source in communication with a source of the other of said second cross-coupled pair of MOS transistors and to a second terminal of said additional attenuating device.

20

53. The quadrature oscillator circuit of claim 52 wherein said first, second, third and fourth attenuating devices each comprises a first capacitor.

54. The quadrature oscillator circuit of claim 52 said additional attenuating device comprises a second capacitor.

55. The quadrature oscillator circuit of claim 46 wherein said second frequency dependent coupling circuit generates a phase shift of the second fundamental frequency.

56. A differential amplifier possessing low phase noise, comprising:
a first transistor having a first terminal to receive an in-phase signal,
and a second terminal to provide an out-of-phase signal;
a second transistor having a first terminal to receive the out-of-phase signal, and a second terminal to provide the in-phase signal;
a first biasing source in communication with a third terminal of said first transistor and a first terminal of a voltage source;
a second biasing source in communication with a third terminal of the second transistor and the first terminal of the voltage source; and
a capacitor in communication with the third terminal of said first transistor and the third terminal of said second transistor, said capacitor decreases gain of said differential amplifier at low frequencies to eliminate phase noise components from the in-phase and the out-of-phase signals.

20

57. The differential amplifier of claim 56 wherein a high pass bandwidth of

*Sub
A1*

said differential amplifier is determined as follows:

$$BW = \frac{g_m}{2\pi Cc}$$

where:

BW is the high pass bandwidth,

g_m is the transconductance of said first and second transistors as measured at the third terminals, and

Cc is the value of said capacitor,

wherein the high pass bandwidth is less than a cutoff frequency of a circuit employing said differential amplifier.

58. The differential amplifier of claim 57 wherein the cutoff frequency of the circuit containing said differential amplifier is from approximately 10 times to approximately 20 times the high pass bandwidth of said differential amplifier.

59. The differential amplifier of claim 56 wherein said first and second transistors are selected from the group of transistors consisting of NMOS transistors, PMOS transistors, and bipolar transistors.

60. The differential amplifier of claim 56 wherein said first and second biasing sources are selected from the group of biasing sources consisting of

current sources and resistors.

61. An oscillator having a fundamental frequency and having low phase noise comprising:

5 frequency dependent amplifier means for amplifying a signal;
frequency dependent feedback means for providing feedback to said
frequency dependent amplifying means; and
attenuating means for attenuating noise signals having a frequency
much less than the fundamental frequency.

10 62. A method of generating a signal having a fundamental frequency with low

noise comprising the steps of:

(a) amplifying a signal;
(b) providing feedback to step (a); and
(c) attenuating the signal in step (a) having a frequency much less
15 than the fundamental frequency.

63. An LC oscillator having a fundamental frequency and having low phase noise

comprising:

a frequency dependent amplifier comprising:

20 a pair of cross-coupled MOS transistors of a first conductivity
type, a drain of each of said pair of cross-coupled MOS
being in communication with a gate of the other one of said
pair of cross-coupled MOS transistors,

a first current source in communication with a source of one of
said pair of cross-coupled MOS transistors, wherein said first
current source comprises a first programmable resistance,
and

5

a second current source in communication with a source of
another of said pair of cross-coupled MOS transistors,
wherein said second current source comprises a second
programmable resistance;

Sub 08
a frequency dependent gain determining circuit comprising

10

a first inductor in communication with the drain of said one of
said pair of cross-coupled MOS transistors and a first
terminal of a voltage source,

15

a second inductor in communication with the drain of the other
of said pair of cross-coupled MOS transistors and the first
terminal of the voltage source,

a first capacitor in communication with the drain of said one of
said of said pair of cross-coupled MOS transistors and a
second terminal of the voltage source, and

20

a second capacitor in communication with the drain of the other
of said pair of cross-coupled MOS transistors and the
second terminal of the voltage source.

64. The LC oscillator of the claim 63, wherein the first current source comprises
a first inductor in communication with said first programmable resistance, and

wherein the second current source comprises a second inductor in communication with said second programmable resistance.

65. An LC oscillator having a fundamental frequency and having low phase noise comprising:

5 a frequency dependent amplifier comprising:

a pair of cross-coupled MOS transistors of a first conductivity type, a drain of each of said pair of cross-coupled MOS being in communication with a gate of the other one of said pair of cross-coupled MOS transistors,

a first current source in communication with a source of one of said pair of cross-coupled MOS transistors, wherein said first current source comprises a first programmable inductance, and

15 a second current source in communication with a source of another of said pair of cross-coupled MOS transistors, wherein said second current source comprises a second programmable inductance;

a frequency dependent gain determining circuit comprising

20 a first inductor in communication with the drain of said one of said pair of cross-coupled MOS transistors and a first terminal of a voltage source,

a second inductor in communication with the drain of the other of said pair of cross-coupled MOS transistors and the first

Sub
08
10
9
8
7
6
5
4
3
2
1
0

terminal of the voltage source,

a first capacitor in communication with the drain of said one of

said of said pair of cross-coupled MOS transistors and a

second terminal of the voltage source, and

5 a second capacitor in communication with the drain of the other

of said pair of cross-coupled MOS transistors and the

second terminal of the voltage source.

66. The LC oscillator of the claim 10, wherein said first current source comprises

a first programmable resistance, and wherein said second current source

10 comprises a second programmable resistance

67. The LC oscillator of the claim 10, wherein said first current source comprises

a first programmable inductance, and wherein said second current source

comprises a second programmable inductance.